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Original Article

Comparison of two different total joint replacement and arthrodesis treatments for advanced hallux rigidus: Short-term functional outcomes

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Abstract

Aim: Hallux rigidus is osteoarthritis of the big toe and is a clinical tableau with progressive pain and movement loss. This study aims to present the clinical outcomes of patients with grade 3 and 4 hallux rigidus unresponsive to conservative treatment who had arthroplasty with two different metallic implants or arthrodesis and to compare the outcomes of these treatments.

Material and Method: Forty patients with arthroplasty or arthrodesis surgery due to hallux rigidus performed by a single surgeon from 2013 to 2018 were retrospectively compared in terms of AOFAS, VAS and ROM measurements and functional scores.

Results: When the clinical outcomes of patients with arthroplasty are compared, there was no statistically significant difference observed. When the arthrodesis group is compared with the arthroplasty groups, separately and combined, there was no statistically significant differences observed in terms of functional scores.

Conclusion: Total joint arthroplasty performed on the big toe offers patients the possibility of a painless metatarsalphalangeal joint (MTPJ) without movement limitations or high complication rates. Arthrodesis is still the most reliable surgical salvage procedure; however, it should be chosen for use as a salvage procedure for stage hallux rigidus that is advanced in terms of function, as with other joints in the musculoskeletal system.

Keywords: Arthroplasty; hallux rigidus; metatarsophalangeal joint; surgical treatment; joint functions.

INTRODUCTION

First MTP osteoarthritis of hallux rigidus is the most common degenerative osteoarthritic situation in the foot1. Hallux rigidus is osteoarthritis of the big toe and is a clinical tableau involving progressive pain and movement loss2,3. Trauma due to direct or iatrogenic causes may lead to arthritis on the injured joint surfaces, but most of the time hallux rigidus is idiopathic4. Hallux rigidus affects nearly 10% of the adult population and is a degenerative disease that peaks in the 6th and 7th decades5,6. Pain and reduced joint movement opening (JMO) are typical clinical findings and it is observed while using stairs, running or jumping involving first metatarsophalangeal (MTP) dorsiflexion, especially7. It mostly has familial inheritance, but some causes like chronic trauma, female gender and others may be blamed in the etiology. There is still no consensus currently about surgical treatment for advanced-stage hallux rigidus7. For treatment of hallux rigidus, choices such as joint restoration, arthrodesis or resection arthroplasty come to the fore and when determining appropriate treatment for the patient age, activity intensity, arthrodesis degree, patient expectations from treatment and disease stage are considered8. Treatment for grade 1 and 2 hallux rigidus are cheilectomy and plantar release9,10. For advanced period hallux rigidus, the most successful treatment for sedentary individuals and elderly patients is arthrodesis10. Arthrodesis is also a choice for patients with concomitant hallux valgus, hallux varus, rheumatoid arthritis and neuromuscular diseases1. Coughlin and Shurnas classified hallux rigidus according to joint movement opening (JMO), clinical and radiological findings7. Arthroplasty provides advantages such as preserving joint functions, stability and preserving toe length. MTPJ arthroplasty began historically with

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silastic implants and advanced toward all metal implants (1,11). When the first silastic implants had high failure rates, the use of metal implants resembling total hip arthroplasty began (11). However, loosening, subsidence and subluxation movements were observed with these implants. This study about patients with grade 3 and 4 hallux rigidus without benefit from conservative treatment aimed to present and compare the clinical outcomes of two groups administered total joint arthroplasty with two different metal implants and one group with arthrodesis performed.

MATERIAL and METHODS

This retrospective study was performed as a comparative cohort study. Patients with MTPJ total arthroplasty of the 1st toe or first MTPJ arthrodesis procedures performed were chosen from among patients with final stage (grade 3, 4) hallux rigidus (Figure1,2,3).

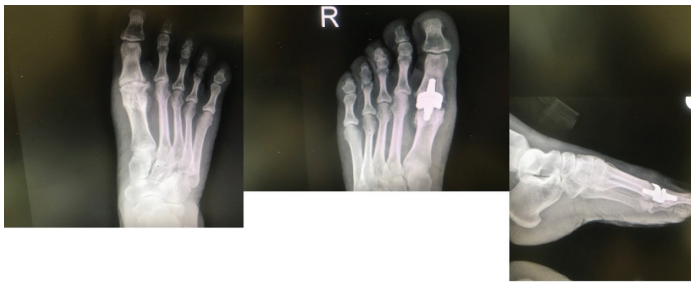

Figure 1. Preoperative radiograph showing severe hallux rigidus and postoperative anteroposterior, lateral radiographs. (GROUP I)

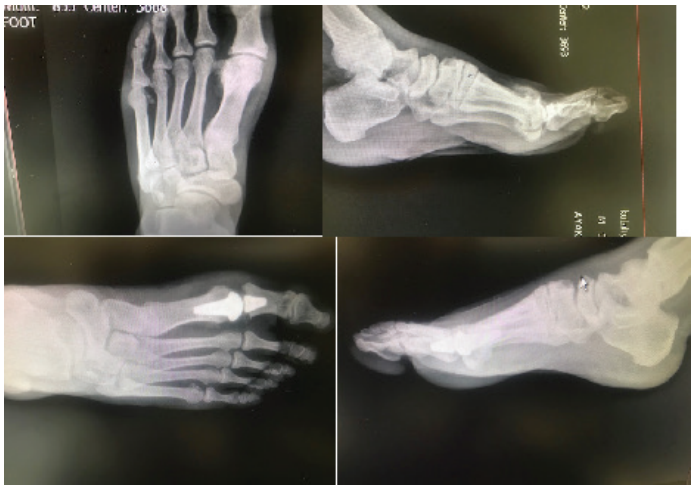

Figure 2. Preoperative radiograph showing severe hallux rigidus and postoperative anteroposterior, lateral radiographs (GROUP II)

Forty patients with total joint arthroplasty and arthrodesis performed from 2013 to 2018 due to stage 3 and 4 hallux rigidus were screened. The retrospective study included 40 patients with diagnosis of isolated hallux rigidus and at least 1-year follow-up (33 arthroplasty, 7 arthrodesis). The arthroplasty patients had Integra Movement Great Toe System (Integra Life- Sciences Corp., Plainsboro, NJ) (figure 1) and Exen (ALEDA Ankara /Turkey) brand implants inserted (figure 2). The pain and functional scores of patients before and after surgery were assessed. Patients were informed in detail about the surgical procedure in the preoperative period and completed informed consent forms. This study was completed in accordance with the Helsinki Declaration.

Foot and Ankle Outcome Score AOFAS ,visual analog scale(VAS) scores and Range Of Motion(ROM) scores were evaluated. Patients with follow-up duration of more than 1 year were included in the study. Patients who died were excluded from the study. Four patients had bilateral total toe arthroplasty, while 1 patient had bilateral arthrodesis procedure performed (Figure 3). Metatarsal and phalangeal head had cartilage tissue reamed with spherical reamers (Figure 4).

Basic demographic data, information about smoking habits, surgical side, pain before surgery, previous small surgeries on the joint, postoperative complications and repeated operations were collected from patients' medical records. Hallux rigidus grade, hallux valgus presence and postoperative consolidation were assessed with radiographs. The radiographic hallux rigidus degree was evaluated according to the clinical scoring system of Coughlin and Shurnas. Patients were requested to participate in the study and complete the surveys. All patients had grade 3 or 4 hallux rigidus according to the Coughlin and Shurnas classification. The exclusion criteria were the presence of preoperative deformity (e.g., hallux valgus, pes planus, pes cavus), preexisting instability of a lesser MTP joint (including joint subluxation or dislocation), inflammatory arthritis (including rheumatoid arthritis), postinfectious arthritis, Charcot neuroarthropathy, and failure to regularly attend the follow-up visits.

Outcome Measures

The visual analog scale (VAS), Foot and Ankle Outcome Score (AOFAS) and Range Of Motion (ROM) measurements were assessed.

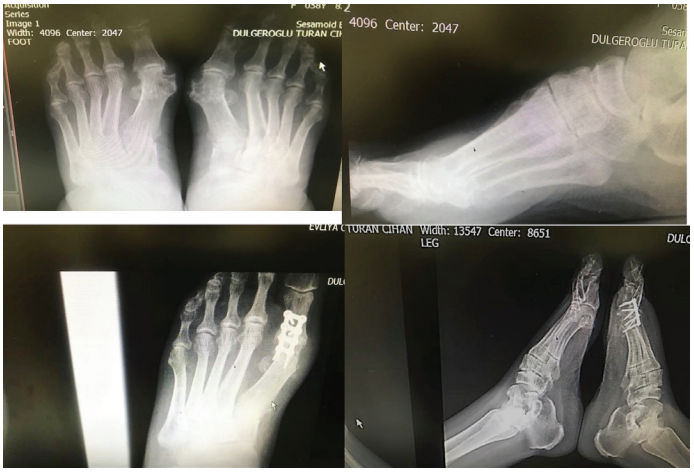

Figure 3. Preoperative radiograph showing severe hallux rigidus and postoperative anteroposterior, lateral radiographs (GROUP III)

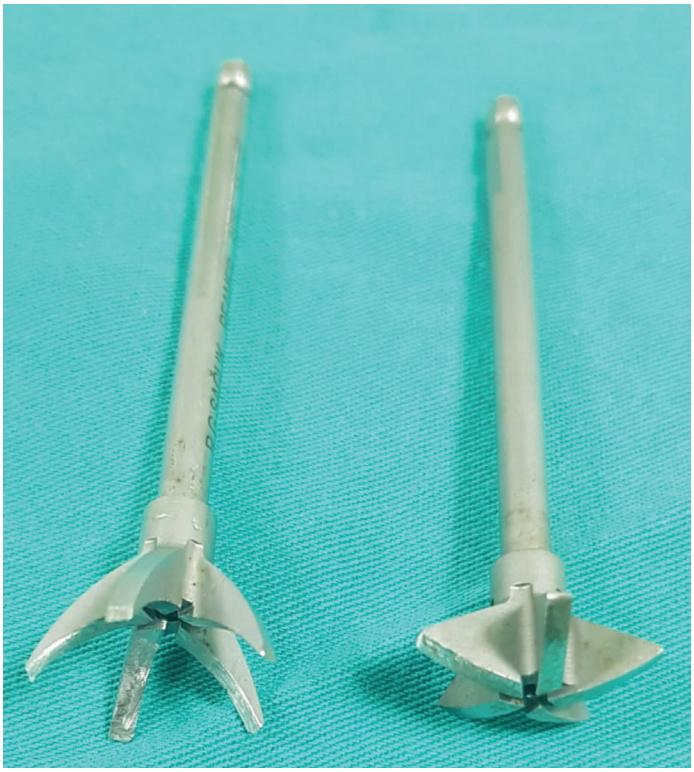

Figure 4. Reamers used to scour the joint surfaces for hallux rigidus

Outcomes

The study was completed with a total of 40 patients in our hospital clinic from 2013 to 2019. Of cases 87.5% (n=35) were female and 12.5% (n=5) were male. The ages of cases ranged from 44 to 74 years, with mean of 64.22±7.99 years.

RESULTS

Group I: Integra movement great toe system
Group II: Ex en system
Group III: Arthrodesis

Table 1. Distribution of descriptive characteristics

Gender; n (%)	Female Male	35 (87.5) 5 (12.5)
Age	Min-Max Mean±sd	44-74 64.22±7.99
Side; n (%)	Right Left	20 (50) 20 (50)
Stage; n (%)	III IV	17 (42.5) 23 (57.5)
Follow-up duration (months)	21.40±1.93 Mean±sd	18-28 21.40±1.93

Of cases, 50% (n=20) had prosthesis of the right and 50% (n=20) had prosthesis of the left big toe.

It was identified that 42.5% (n=17) of cases were stage III and 57.5% (n=23) were stage IV.

The follow-up durations for patients varied from 18 to 28 months, with mean of 21.40±1.93 months (Table 1).

Table 2. Distribution of ROM, VAS and AOFAS values

		Before	After
ROM	Min-Max Mean±sd	15-45 22.82±7.03	0-90 64.87±30.87
VAS	Min-Max Mean±sd	7-10 8.35±0.77	7-10 8.35±0.77
AOFAS	Min-Max Mean±sd	24-32 27.30±2.46	24-32 27.30±2.46

The preoperative ROM values for cases varied from 15 to 45 units, with mean of 22.82±7.03 units. After the procedure, values varied from 0 to 90 with mean of 64.87±30.87 units.

The preoperative VAS scores of cases varied from 7 to 10, with mean of 8.35±0.77; while postoperatively these values varied from 1 to 3 with mean of 1.72±0.68.

The preoperative AOFAS scores of cases varied from 24 to 32 with mean of 27.30±2.46. The postoperative AOFAS values varied from 65 to 88 with mean of 76.62±8.22.

Table 3. Comparison of descriptive characteristics between the groups

		Group 1	Group 2	Group 3	P
Gender; n (%)	Female Male	16 (88.9) 2 (11.1)	12 (80) 3 (20)	7 (100) 0 (0)	[a]0.569
Age	Median (Q1. Q3)	65 (61. 72)	61 (58.71)	69 (65. 73)	[b]0.109
Stage; n (%)	III IV	6 (33.3) 12 (66.7)	8 (53.3) 7 (46.7)	3 (42.9) 4 (57.1)	[a]0.488
Follow-up duration (months)	Median (Q1. Q3)	21.5 (20. 23)	22 (20.23)	21 (19. 23)	[b]0.831

[a]Fisher-Freeman-Halton exact test, [b]Kruskal-Wallis test, Q1: first quartile, Q3: third quartile

There was no statistically significant difference between the groups in terms of gender of cases (p>0.05).
There were no statistically significant differences between the groups in terms of age, stage and follow-up duration (p>0.05).

Table 4. Comparison of ROM, VAS and AOFAS values between the groups

		Group 1	Group 2	Group 3	P
ROM PreOp	Median (Q1.Q3)	20 (20.25)	20 (15.25)	25 (20.29)	[b]0.212
ROM PostOp	Median (Q1.Q3)	80 (75.85)	75 (75.80)	0 (0.0)	[b]<0.001**
VAS PreOp	Median (Q1.Q3)	8 (8.9)	8 (8.9)	9 (8.9)	[b]0.643
VAS PostOp	Median (Q1.Q3)	2 (1.2)	2 (1.2)	2 (1.2)	[b]0.997
AOFAS PreOp	Median (Q1.Q3)	27 (26.29)	27 (25.28)	28 (25.32)	[b]0.657
AOFAS PostOp	Median (Q1.Q3)	77.5 (66.85)	75 (66.85)	76 (76.80)	[b]0.816

[b]Kruskal-Wallis test, Q1: first quartile, Q3: third quartile, **p<0.01

There was no statistically significant difference between the groups in terms of the preoperative ROM values (p>0.05).

There was a statistically significant difference between the groups in terms of postoperative ROM value (p<0.001). According to Dunn-Bonferroni test results, cases in Group 3 were identified to have lower values than cases in Group 1 and Group 2 (p<0.001, p:0.002, respectively). There were no differences identified between Group 1 and Group 2 (p>0.05).

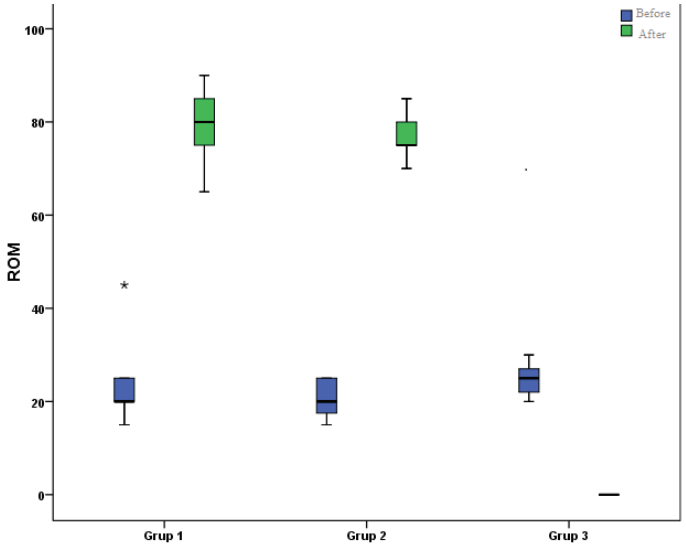

Figure 5. Distribution of ROM values in the groups

There was no statistically significant difference between the groups in terms of preoperative and postoperative VAS values (p>0.05).

There was no statistically significant difference identified between the groups in terms of preoperative and postoperative AOFAS values (p>0.05).

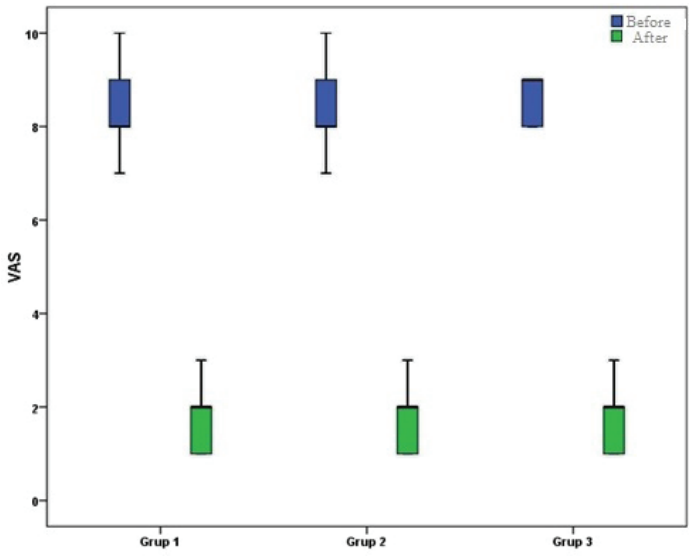

Figure 6. Distribution of VAS values in the groups

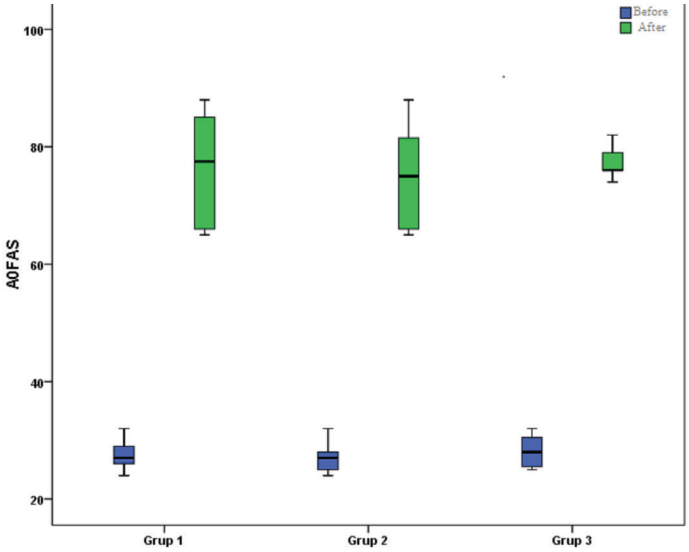

Figure 7. Distribution of AOFAS values in the groups

Table 5. Comparison of descriptive characteristics between the groups

		Group 1 & 2	Group 3	P
Gender; n (%)	Female Male	28 (84.8) 5 (15.2)	7 (100) 0 (0)	[c]0.565
Age	Median (Q1. Q3)	62 (61. 72)	69 (65.73)	[d]0.063
Stage; n (%)	III IV	14 (42.4) 19 (57.6)	14 (42.4) 19 (57.6)	[c]0.999
Follow-up duration (months)	Median (Q1. Q3)	22 (20. 23)	21 (19.23)	[d]0.676

[c]Fisher's exact test, [d]Mann-Whitney U test, Q1: first quartile, Q3: third quartile

There were no statistically significant differences between the groups in terms of gender, age, stage and follow-up duration (p>0.05).

Table 6. Comparison of ROM, VAS and AOFAS values between the groups

		Group 1 & 2	Group 3	P
ROM PreOp	Median (Q1.Q3)	20 (20.25)	25 (20.29)	[d]0.102
ROM PostOp	Median (Q1.Q3)	80 (75.85)	0 (0.0)	[d]<0.001**
VAS PreOp	Median (Q1.Q3)	8 (8.9)	9 (8.9)	[d]0.401
VAS PostOp	Median (Q1.Q3)	2 (1.2)	2 (1.2)	[d]0.945
AOFAS PreOp	Median (Q1.Q3)	27 (25.28)	28 (25.32)	[d]0.421
AOFAS PostOp	Median (Q1.Q3)	77 (66.85)	76 (76.80)	[d]0.835

dMann-Whitney U test, Q1: first quartile, Q3: third quartile, **p<0.01

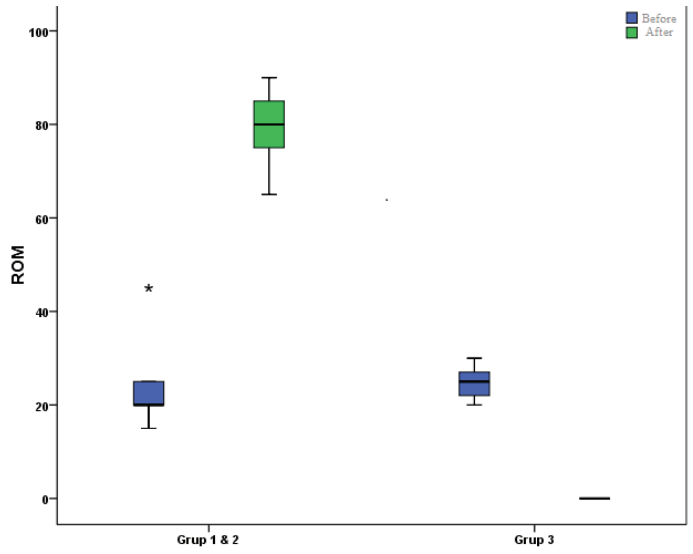

Figure 8. Distribution of ROM values in the groups

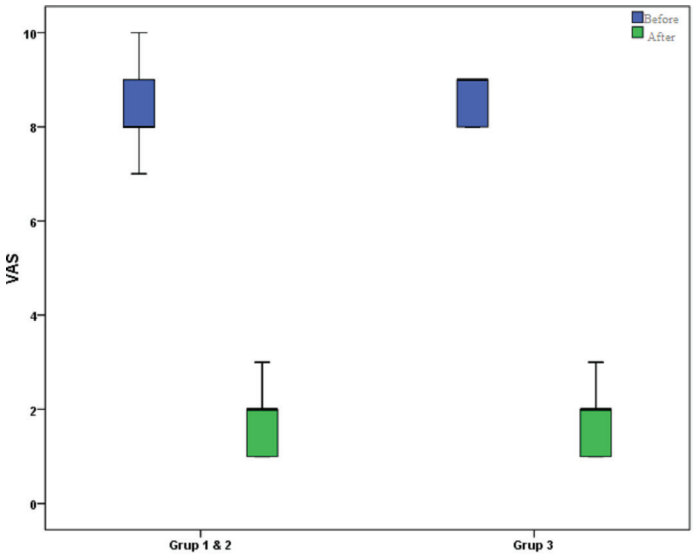

Figure 9. Distribution of VAS values in the groups

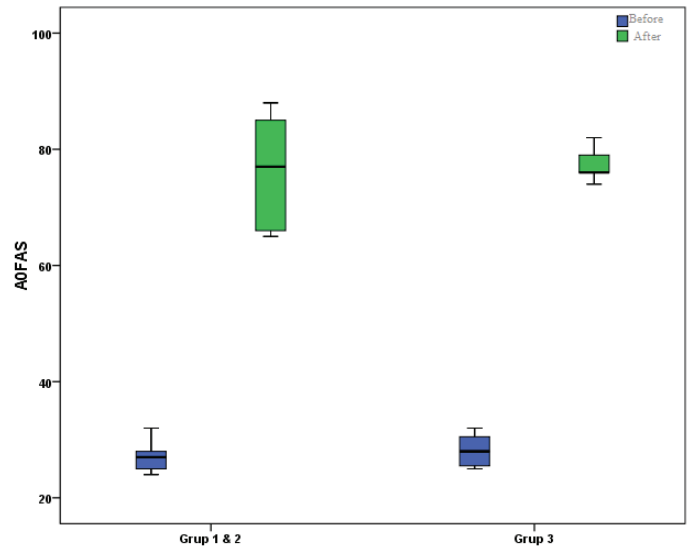

Figure 10. Distribution of AOFAS values in the groups

There was no statistically significant difference identified between the groups in terms of preoperative ROM values ($p>0.05$).

There was a statistically significant difference identified between the groups in terms of postoperative ROM values ($p<0.001$). The cases in Group 3 were identified to have lower values compared to the cases in Group 1&2.

There was no statistically significant difference identified between the groups in terms of preoperative and postoperative VAS values ($p>0.05$).

Statistical Analysis

The NCSS (Number Cruncher Statistical System) 2007 (Kaysville, Utah, USA) program was used for statistical analysis. When evaluating the study data, descriptive statistical methods (mean, standard deviation, median, first quartile, third quartile, frequency, percentage, minimum and maximum) were used. The fit of quantitative data to normal distribution was tested with the Shapiro-Wilk test and graphical investigations. Comparison between two groups of quantitative variables without normal distribution used the Mann-Whitney U test. Comparison between more than two groups of quantitative variables without normal distribution used the Kruskal-Wallis test and Dunn-Bonferroni test. The Fisher exact test and Fisher-Freeman-Halton exact test were used for comparison of qualitative data. Statistical significance was accepted as $p<0.05$.

DISCUSSION

The aim of this study about end-stage hallux rigidus patients was to compare the clinical outcomes of two separate total toe arthroplasty techniques, separately and together, with patients administered arthrodesis. We did not find any significant difference between arthroplasty and arthrodesis patients in terms of VAS and AOFAS scores. There was a significant difference between surgical outcomes for ROM scores. Our study has sufficient patients when compared with other studies.

Hallux rigidus is a common public health problem affecting nearly 10% of the adult population (12,13). The disease is generally observed in the elderly population and mainly among women (14). The target of hallux rigidus treatment is to provide a functional extremity and prevent pain while meeting the expectations of patient and clinician. Arthrodesis is defined as the gold standard for hallux rigidus treatment (1).

First metatarsophalangeal joint fusion of the first toe is one of the most frequently chosen treatment methods, as for many other diseases. However, arthrodesis may have unwanted side effects similarly limiting daily activities (1,15). Arthroplasty is an alternative treatment choice for HR. It has been used for the last 60 years to remove the disadvantages of other procedures like metatarsal osteotomy, resection arthroplasty and joint fusion (3,16). Ideal joint arthroplasty will resolve joint pain, preserve and even improve joint functions and ensure joint stability

(16,17). The effort to find this ideal implant has led to the development of many silastic, ceramic and metallic arthroplasty implants in the last 3 decades (18).

Though arthroplasty is an exciting option, there are reports of failure in long-term outcomes in the literature (19,20). It is very attractive for many patients who wish to preserve joint movement. Additionally, due to biomechanical difficulties of the 1st MTPJ, this surgical procedure may result in failure in long-term outcomes. Good results are reported for total joint arthroplasty during short-term follow-up. However, in the long term some problems may occur like reactions between these metal or silicone implants and soft tissue, joint hardening, subluxation, silicon synovitis and osteolysis. In spite of poor outcomes from first designs and flexible hinged silicon prostheses, new-generation implants are observed to provide better and hopeful outcomes (16,17,21). Barwick and Talkhani in a study reporting the functional outcomes for 22 patients with ceramic total joint arthroplasty reported 12.5% revision rate and stated 63% of patients were "very satisfied" with the procedure (22). McGraw et al. in medium-term follow-up data from 48 patients reported 91% good functional outcomes with implant survival during 44 months of follow-up (23). Pulavarti et al. reported 77% mean perfect satisfaction and 0.4% revision after TJR during 47 months of follow-up (24).

Additionally, complications like delayed healing, nonunion, shortness, metatarsalgia, limited recreational activity, adjacent joint problems and difficulty wearing shoes may be encountered with arthrodesis25. Patients initially want reduced pain and a functional extremity. The classification system by Coughlin and Shurnas was developed to define hallux rigidus with radiologic and clinical findings7. Accurate classification of patients is important while selecting treatment (26,27). Patients with hallux rigidus initially gain good clinical outcomes from painkillers, shoe modifications, activity changes and steroid injections; however, patients that do not respond to these treatments may consider surgical treatment similar to synovectomy, cheilectomy and plantar release (9,10,11). We use these treatment protocols mainly for grade I-II hallux rigidus treatment. These treatments are not often chosen for treatment of advanced-stage hallux rigidus. In the literature there are many studies related to arthrodesis and arthroplasty. Another surgical method for hallux rigidus is to remove the joint movement to obtain a pain-free metatarsophalangeal joint and was reported to have good outcomes after arthrodesis in the literature1. When resection interposition arthroplasty was compared with other surgical treatment methods, problems like instability, push-off weakness and shortness were encountered more frequently. Fusion has success rates varying from 92-100% after sufficient fixation (1,28). When the arthroplasty groups were compared separately and combined with the arthrodesis group, there were no statistically significant short-term results found in terms of AOFAS and VAS scores. In terms of complication rates, there was no statistically significant outcome or difference observed. Additionally, there was no statistically significant difference observed between the arthroplasty groups.

Arthrodesis surgery is a reliable treatment method as a salvage procedure and can be used as a salvage procedure and primary treatment for advanced stage hallux rigidus, as for other joints in the musculoskeletal system. Additionally, it continues to be indispensable for stopping pain with perfect patient satisfaction. Total joint arthroplasty offers the opportunity for a pain-free MTPJ with no movement limitation and without high complication rates.

In the literature, there are few studies on the results of total joint arthroplasty for hallux rigidus and comparison with arthrodesis. In this study we obtained similar results analogical studies (29). Raikin et al (25) compared 21 hemiarthroplasty and 27 arthrodesis procedures. They reported that the AOFAS, VAS, and satisfaction scores were better in the arthrodesis group Erdil et al (29) compared three different methods (total joint arthroplasty, hemiarthroplasty and arthrodesis) treatment of advanced staged HR. They finded similar results with three different methods effectiveness of advanced HR . However, to our knowledge, this is the first study comparing each other the results of two different total joint arthroplasty and comparing with arthrodesis.

In our study, we obtained significant improvements in the AOFAS score and a significant decrease in the VAS score in all groups with short-term follow-up. No statistically significant differences were found among the arthrodesis, total joint replacement groups according to the AOFAS and VAS score at the last follow-up visit.

The retrospective nature was the main limitation of our study. The number of patients in this study is relatively small, which can be considered a limitation of the research. Since there was only one surgeon and a population disease that was relatively small for orthopedics clinics, more patients could not be included in the study. Also, no statistically significant differences were found in the incidence of complications.

CONCLUSION

In conclusion, arthroplasty and arthrodesis provide good clinical outcomes in the short term for advanced-stage HR treatment.

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Ethical approval: This work has been approved by the Institutional Review Board.

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